

AMATEUR TELEVISION FOR EMERGENCY COMMUNICATIONS

A presentation by Dave Mann & Lee Bond, Saturday, April 5th, 2008 at the “2008 Communications Academy” held in Seattle, Washington.

The goal of the presentation was to show the ABC's of setting up an Amateur Remote Portable Television Station, with emphasis on emergency Communications and Public Service. A show and tell setting between two stations with comments by Dave, KD7ZYM, a 45 year veteran television photojournalist with live remote microwave set-up experience for local and national television news casts.

For the technical inclined, Lee, N7KC, assisted the presentation with double teaming to present the nuts and bolts of how and why Amateur Television works using Broadcast TV instrumentation, displaying wave forms and showing how video, color and audio is transmitted. Lee is an Electronics Technician with over 45 years of experience in the field of radio engineering, with a passion for Commercial Broadcast Television.

Dave's Notes:

USING VIDEO FOR COMMUNICATIONS

It has been said over and over again, “A PICTURE IS WORTH A THOUSAND WORDS”. With the use of Amateur Television the words can be painted by transmitting live video and recorded images with sound, over the amateur radio spectrum by Ham radio operators like ourselves.

We all have watched commercial Television Newscasts for Local and National News, where we see both live and recorded events of major news events. As an amateur radio operator holding an entry level Technician class license, we have the same privilege to transmit video and audio over the airwaves using the Ham Radio UHF, VHF and higher bands.

In emergency communications we all focus on sending messages in Voice, Digital text and the slower Morse code, back and forth from the field and Emergency Operation Centers. With Amateur Television, we add the element of color, moving and still pictures for damage assessments, far better in visual detail than could be portrayed with pages and pages of written text, plus the addition of audio.

It does seem too good to be true..... All good things have limits. With Amateur Television you have to have LINE OF SIGHT between transmitters and receivers and reasonable transmission distance for video and sound is around 60 miles for an 80 watt transmitter. Smaller ATV transmitters, ¼ to three watts have a range of several city blocks with low power and up to 15 miles with a three watt transmitter. From an aircraft to a ground station, again line of site, one could get a reasonable picture up to five miles with a one watt transmitter. With a 20 watt transmitter one should expect to transmit good video up to 30 miles.

Commercial Television also has the same LINE OF SIGHT problems that face us as Ham ATV operators but they set up repeater stations and can use helicopters for relays and Satellites to get video back to the TV stations. Also TV stations have the use of automatic tracking antenna systems costing thousand of dollars and have the deep pockets to afford it.

In amateur TV we also have the ability to send LIVE VIDEO to set-up relay stations, use repeaters for video just like we use for UHF and VHF radios and also transmit video from aircraft. We also have the ability to record video and play it back on ATV.....in the future ATV on Amateur Satellites is on the drawing boards.

When it comes to ATV rule number one is for high quality video and audio is LINE OF SIGHT, rule number two is TRANSMITTER OUTPUT POWER, and a very important rule number three is SIZE DOES MATTER when it comes to antennas, we will cover that later.

Now that we know the limits for ATV, just think off all the things we can use this medium for Emergency Communications. No other medium can portray damage assessments better than a use of television video images. Catastrophic Earthquake, flood, tornado and storm damage live or recorded on video tape, transmitted to a Local, County or State Emergency Operations Centers can give instant views on what is happening and what is needed to assist officials with response and recovery operations.

ATV can be used to monitor emergency shelters, view images for health assessments and used for teleconferences in the field to EOC's, where the pictures and audio can be projected on TV monitors and Video Walls helping management officials make decisions for assistance. In essence ATV can be the eyes to the outside world, in real time for the decision makers.

Video from an aircraft can monitor field response, show structure damage and give an overall view of damage in effected areas. If a live picture can't be transmitted due to a LINE OF SIGHT issue, a camcorder can be used to record the event and video then played back when a LINE OF SIGHT transmission can be made.

Another item that can be transmitted besides pictures and audio is the overlaying of text messaging over the video. An example would to send standard ARRL formal radiogram messages or emergency and priority messages to EOC's using scrolling text across the screen during the ATV transmission.

ATV can also be used to send video to Served Agencies and for Public Service to track progress of parades, races, and traffic control. As amateur radio operators we can assist in both Emergency and Public Service by setting up and operating ATV stations.

SETTING UP FOR FAST SCAN AMATEUR TELEVISION

1. NTSC video (1 Vp-p) source: Block camera with lens, Camcorder, VCR, DVD Playback or a PC to TV component converter (scan-converter).

2. Tripod or other support for camera stability for live video transmissions.
3. Power supply or battery for video source & power cable.
4. Coax 75 ohm cable to connect video source to ATV transmitter.
5. Audio source: 600 ohm microphone for live audio or Line Output from a recorder for pre-recorded audio.
6. Cable to connect audio source to ATV transmitter.
7. ATV transmitter $\frac{1}{4}$ watt to 20 watts with audio sub carrier board (Video only transmitter can be used if sound is not wanted)
8. 12 Volt DC Power supply or battery for the ATV transmitter.
9. Power cable for ATV transmitter.
10. 12 Volt DC NTSC Video monitor (Can share power with ATV transmitter) used to view video source being transmitted. 115V NTSC TV set with a video input can also be used but would not be used for portable operation. Video monitor will need a power cable.
11. Video monitor coax 75 ohm cable for use between the Transmitter/Receiver and the Video Monitor.
12. Transmitter to Antenna, 50 Ohms coax cable (Low loss 9913 with N-fittings)
13. Transmitting antenna: A ground plane antenna can be used for short distance communications but for long distance a high gain yagi is recommended (This is where size does matter, the more elements the better the transmission will be.
14. To receive ATV video and sound a 12 Volt Video down converter is needed. This device converts the video to a NTSC signal on a standard television channel. Some ATV transmitters have a built-in down converter and have a T/R switch built in and share a common antenna.
15. Receiving Antenna if using an ATV Down Converter not attached to the ATV transmitter that shares a T/R antenna. Again size does matter, a high gain yagi is recommended.
16. Receiver to Antenna, 50 Ohms coax cable (Low loss 9913 with N-fittings).
17. Antenna Mast for Transmitting and/or Receiving antenna/
18. 12 Volt DC Power supply for the Down Converter or battery if the Down Converter is not built into the ATV transmitter.

19. A 75 ohms TV Coax antenna cable with F-Fittings to connect the Down Converter to a NTSC television set antenna input.
20. NTSC Television receiver for video and sound reception from the Down Converter. Battery operated for field use or 115V AC if TV set is not being used portable.
21. Accessories: Text video overlay generator if you wish to send text over your transmissions or use to identify you ATV station. Special video overlay generators can be used also to display GPS data, speed and time from moving aircraft or other moving platforms. Another useful device would be a switcher used to route various video and audio to the ATV transmitter. A portable video lighting kit would come in handy in low light situations or a battery powered on-camera light would be useful.
22. Power Amplifier for boosting your ATV transmitter to the 80 Watt range if desired. With this option it is recommended to power the amplifier with a separate power source not the same one powering your ATV transmitter. Also an additional 50 ohm cable with N-Fittings would be needed to connect the ATV transmitter to the amplifier.

ANTENNA NOTE:

Antennas for use in Fast Scan ATV are polarized either vertical or horizontal. A ground plane antenna is almost always vertically polarized but yagi antennas can be either vertical or horizontal polarized. For transmitting and receiving the same ATV frequency the antennas have to be matched in the same polarization plane. Cross-Band repeaters use opposite antenna polarization for up-link and down-link transmission functions; IE: up-link, horizontal polarization; down-link vertical polarization.

The reason for low loss antenna cable, N-Fittings on the antenna cables and high gain yagi antennas is to maximize the low power coming from the ATV transmitter and increase the gain on the Down Converter for receiving.

ESTABLISHING COMMUNICATIONS FOR FAST SCAN TELEVISION STATIONS

LINE OF SIGHT is the number one rule for Fast Scan Amateur Television, so using 2-meter Radio simplex for voice communications is the choice for setting up two ATV stations for simplex operations. Fast Scan ATV is transmitted on 70 cm so interference from 2-meter radio voice transmissions is at a minimum. Once a 2-meter communications link is established, each ATV station operator can alternately transmit and receive to tune in the maximum signal by aligning yagi antennas for maximum performance. Again, always make sure your antennas have the same polarization. Once your ATV link is established simplex audio communications can be made on the ATV sub carrier as well as being able to transmit video, you have established a two-way ATV link. Remember this is a simplex operation so only one station at a time can transmit. When the ATV transceiver is not transmitting it is in the receive mode.

The same procedure can be used to establish a one-way link when only video and audio are sent to a receiving station. This would be the same method used for down linking video from an aircraft or moving object that is using a ground plane transmitting antenna. With a moving object transmitting on a ground plane antenna the receiving station would have to track the transmitting station with a vertical polarized yagi for a long distance transmission or for a short distance transmission, a ground plane antenna would work fine. Audio on the ATV sub carrier would only be one way so the 2-meter communication link would be your primary source for two way communications.

USING A CROSS BAND REPEATER FOR FAST SCAN ATV

Fast Scan ATV repeaters work very much like standard UHF / VHF repeaters that are used every day by Ham's, however the only difference is the LINE OF SIGHT rule. By having a relay station located at a high point or mountain top ATV transmissions can connect stations that have issues due to LINE OF SITE obstructions, providing both stations have LINE OF SIGHT to the repeater.

The major issue with ATV repeater stations is that they almost always use omni directional antennas for both receiving and transmitting, limiting their long range transmission and receiving capabilities. In commercial TV stations, very expensive high gain automatic tracking antennas are used for receiving and transmitting video and audio signals, again commercial broadcasters have deep pockets.

Here in the Greater Puget Sound area the **Western Washington Amateur Television Society** operates a cross band repeater station (KC7ZYD) located at Cougar Mountain and has an emergency back-up power source. This is an open repeater for all wishing to use it. The society uses the repeater twice weekly for a one hour controlled net on Saturday and Tuesday evenings at 8 PM to send and receive full color and sound ATV live video, transmit pre-recorded video and use video for show and tell projects.

The WWATS station has an up-link frequency of 434 MHz and down-links on 1.25325 GHz and for scheduled nets has an agreement to use the (W7WWI) repeater 147.08 + with a tone of 103.5. The 147.08 repeater is operational on either Tiger or Cougar Mountain. Outside of the scheduled ATV nets the society uses the simplex frequency of 146.42 for communications. Any simplex or open repeater frequency can be used outside the structured nets for setting up communications for use with the WWATS repeater.

Antenna polarization is very important with the use of the WWATS repeater. For up-link the polarization is horizontal on 434 MHz and recommended you use a mutable element yagi antenna for transmission gain. Down linking transmission is on 1.25325 GHz and is vertically polarized. For receiving the down link you will need a 1.2 GHz down converter which receives

the retransmitted signal and converts the video and audio to a standard NTSC television receiver TV channel.

Receiving the 1.2 GHz signal can be a bit challenging so here is where the number three rule SIZE DOES MATTER comes into play.....you want a yagi antenna with the greatest amount of gain that you can afford, gain is proportional to the number of elements in the antenna, the more elements the better. Use low loss cable from the antenna to the converter and for long distance ATV downlink reception of video and audio, you may need to install a preamp at the antenna to boost the antennas receiving capability.

Location, Location and Location is often referred to operating a successful retail business. This concept applies to ATV as well, you have to have the right LOCATION with LINE OF SIGHT to participate with ground station to ground station transmissions and ground station to repeater transmissions.

To find out more about the WESTERN WASHINGTON AMATEUR TELEVISION SOCIETY you are urged to join their nets on Saturday and Tuesday evening at 8 PM on the 147.08 MHz repeater. At present the WWATS internet site is being redesigned, unfortunately the person controlling the site passed away taking along the password to operate the site.

EQUIPMENT! PLUG AND PLAY vs HOME BREW

The question always comes up how much does it cost to set up an ATV station, it could be from few hundred dollars to well over one thousand dollars for plug and play equipment. I think that a good ball park figure is about half the price of setting up an amateur HF station.

A plus is that most people interested in HAM TV already own a video camcorder that can be used as a video source and are already familiar what can be done with video. Most of the new digital still cameras have NTSC video outputs like the camcorders and can be used also for live video. By adding a computer scan-converter to your ATV station anything on your computer screen can be converted to NTSC video and transmitted including playing back DVD's and other video stored on your computer.. As you can see a lot of us may have video resources available to use that we have not even thought about.

For me I prefer the plug and play path, you don't have to reinvent the wheel as the saying goes. With Fast Scan ATV, home brewing is an option to those who have the knowledge and skills to carry out that task. After all home brewing is the backbone of Ham Radio, but not for the light of heart.

A lot of transmitting, amplifiers, and audio modules are on the market for the home brewers to assemble into complete transmitting and receiving stations for the 70 cm and 23 cm bands. Some issues come to mind with working on 23 cm band transmission and reception gear as a lot of test equipment is not available to the average ham radio operator to align this 1.2 GHz equipment.

When it comes to antennas for home brewers, “The ARRL ANTENNA BOOK” is the ultimate reference for Amateur Radio antennas, transmission lines and propagation.....all kinds of designs for 70 cm and 1.2 GHz antennas can be found in this publication for ATV use.

The largest supplier of ATV equipment in the United States is PC Electronics located at 3522 Paxson Lane; Arcadia CA 91007-8537. Telephone 626-447-4565. Web Site: <http://www.hamtv.com> .

MFJ Enterprises, Inc. 300 Industrial Park; Starkville, MS 39759 sells some low powered ATV transmitters and is great source for power amplifiers for ATV 70 Cm transmitters. Web Site: www.mfjenterprises.com

Videolynx; 19910 Bramble Bush Dr; Gaithersburg, MD 20879 sells synthesized video/audio transmitters.
Web site: www.transmitvideo.com .

“A” LINE RESTRICTIONS ON 70cm AMATEUR RADIO BAND TRANSMISSIONS”

An item to be noted for Fast Scan ATV in the Puget Sound Region is the line “A” transmission restriction in the FCC Part 97 rules. The line passes East and West through Renton and intersects Cougar and Tiger Mountains the rule restricts transmissions below 430 MHz on the 70cm Band.

Part 97.303 (f/1) No amateur station shall transmit from north of line A in the 420-430 MHz segment.

Part 97.303 (f/2) The 420-430 MHz segment is allocated to the amateur service in the United States on a secondary basis, and is allocated in the fixed and mobile (except aeronautical mobile) services in the International Table of allocations on a primary basis. No amateur station transmitting in the band shall cause harmful interference to, nor is protected from interference do to the operation of stations authorized by other nations in the fixed and mobile (except aeronautical mobile) services.

Line A. Begins at Aberdeen, WA, running by great circle arc to the intersection of 48° N, 120° W, thence along parallel 48° N, to the intersection of 95° W, thence by great circle arc through the southernmost point of Duluth, MN, thence by great circle arc to 45° N, 85° W, thence southward along meridian 85° W, to its intersection with parallel 41° N, thence along parallel 41° N, to its intersection with meridian 82° W, thence by great circle arc through the southernmost point of Bangor, ME, thence by great circle arc through the southernmost point of Searsport, ME, at which point it terminates.

Lee's Notes:

UNDER THE HOOD

A brief tour of NTSC defined television and the composite video signal, the most elegant waveform to be found in analog communications systems.

Talk about post WWII- no computers, no transistors, no ASIC's, no printed ckt boards, no LCD's, no DSP vacuum tubes, point to point wiring, high voltages, etc.
advent of color transmission in 1953, etc.

General overview of the generation, transmission, and display process.
How do you transmit a picture from point A to point B

Generation- The scanning, synchronizing, and timing process
how a vidicon works, show example
contrast monochrome vs. color i.e. single sensor vs. 3 sensors + filters
why RGB additive, Y vs. Y', gamma, $Y' = .299R + .587G + .114B$
B-Y', R-Y' color difference signals
why timing and sync is so important
horizontal and vertical sync, fields and frames
why interlacing and how does it work
how the composite signal is assembled per NTSC
project waveform monitor signal for illustration
describe IRE units as it relates to 1v p-p

The transmission process
conventional AM spectra with single modulating frequency
spectra of $(\sin x)/x$,
subcarrier encoding of color information, R-Y' & B-Y' matrix to I & Q, QAM, the color burst
how the spectra fits together
describe VITS, closed captioning, XDS (auto clock set)
project commercial spectra example JPG
the FM aural channel, SAP, PRO channel

The display process
recovery of picture components
shadow mask, phosphors, and guns

Using antenna, Tek DS1001 demodulator, Tektronix TDS3012 DPO, Magni 1520, and LCD projector. Real time projection of 75% SMPTE color bars, VITS, etc. with oscilloscope.

Real time projection demo of a commercial signal showing line by line on oscilloscope waveform monitor including horizontal sync, vertical sync, color burst, VITS signals, etc.

Suggested reading-

Television Fundamentals, John Watkinson, 1996, ISBN 0-2405-1411-4

Video Demystified, Keith Jack, 5th ed., 2007, ISBN 978-0-7506-8395-1

Digital Video and HDTV, Charles Poynton, 2007, ISBN 978-1-55860-792-7

Image Communications Handbook, ARRL, Ralph Taggart, WB8DQT, ISBN 0-87259-861-6

Additional information on the electronics how and why can best be found in, "The ARRL HANDBOOK FOR RADIO COMMUNICATIONS" in Chapter 12, under FAST-SCAN TELEVISION. This reference book has pages of technical information on transmitting and receiving theory plus applications and is well worth your time reading to get a better understanding how ATV works.

ANOTHER VIEW ON ATV OPERATIONS

I don't think than any body can put it in words better than Tom O'Hara W6ORG, owner of P.C. Electronics.

WHAT CAN YOU PUT ON ATV?

Any Technician class or higher radio amateur can transmit ATV to other amateur frequencies above 420 MHz, and Novices on 1270-1295 MHz. Besides showing you and your gear in the shack, you can show and describe your latest projects in detail, copy schematics, help debug computer programs, put on your own home video tapes and movies, computer graphics and games, repeat Space Shuttle video from the NASA Select satellite channel, repeat SSTV, RTTY, Packet, etc. to ATV. You can repeat computer generated weather radar or satellite video for skywarn and emergency amateur radio groups. Transmit the local radio club meeting to those that physically can't make it. Virtually any non-commercial video from your camera, VCR or NTSC compatible computer is simply plugged into the video in jack and sent exactly as you would see it on the local monitor.

ATV is a big help for getting an overview of an operational situation during parades, races, search and rescue operation , major fires, floods, major wind storms and other disasters. Public service is a great way to have fun with your ATV gear. Your transmissions must be controlled by licensed hams, and directed primarily to another ham. ATV has been used for public service in vehicles, portable boats, airplanes and helicopters. For portable, a 20 watt compact portable transmitter can be carried in a knap-sack, a short coax run to a ¼ wave ground plane, audio clipped into the headset/mic, and plugged into a 6 Amp/hr gel cell battery. The OAL 5L-70cm beam is only 31" long, 8 dB gain and its >60 degree beam width cuts down the multipath ghost problem from reflected RF coming in from the sides and back at the receive site. 2 Radio shack 5 ft mast sections and tripod fit easily in the car with the beam for portable operations.

If used in an aircraft for fun or remote damage assessment with emergency service groups or CAP, run RG400 (available at businesses that do cellular telephone installations in cars) or RG142 coax instead of RG58 coax to the antenna. Ordinary coax will put noise in the picture

due to vibration modulation – there is enough attenuation change as the ohmic contact between adjacent stands of the coax shield rub back and forth. Use only a stiff quarter-wave spike on the bottom of the aircraft to minimize radiation nulls as the plane banks – so not use gain antennas. FAA certified antennas for the amateur bands are available from Comant (562) 946-6694. Snow free line of sight DX with the Quarter wave on the belly to a 9 10 dB omni (F718) on the ground is 25 miles.

WHAT CAN'T YOU DO WITH ATV?

All the FCC rules and regs in part 97 apply (47 CFR). The ARRL FCC Rule Book is a good reference that explains all these by practical examples. All amateur transmissions must be directed to another amateur and few exceptions for control, tests or emergencies (97.113, 97.215, 97.401 to 97.405). Therefore ATV cannot be used for surveillance purposes for personal, business or law enforcement. You cannot “broadcast” (97.113) to a non-amateur or retransmit any other radio service (except Space Shuttle Video and audio) or music. ATV cannot be used as a cheap link for local cable or public access community TV systems, church service, video or movie production directly or indirectly. Basically you cannot use Amateur radio to further any business purpose, profit or non-profit or activity contrary to Federal, State, or local law. There are frequencies and licensing for these purposes.

Teachers who are licensed radio Amateurs can transmit to another amateur, classroom to classroom, or to other schools as long as it is used to demonstrate Amateur radio or radio communication or for fun between school radio clubs. They cannot, however, transmit normal lessons, broadcast school sporting events or other school business.

STATION IDENTIFICATION.

You must identify with your call letters every 10 minutes and at the end of every transmission (97.119). This can be done by voice on the sound subcarrier or by call letters on the screen. If done on video, the letters must be large enough to be easily seen in the picture. Many just put up a large call sign with black letters on white board on the shack wall in normal camera view. You can get fancy by overlaying your call letters over the camera video with an OSD board in the video line, or computer generated special effects. In weak signal condition, it has been found that large, flat black letters on white background which fill the whole screen show up best in the snow. Others use a computer and switch between the camera and generated graphic call sign.

LIGHTS AND CAMERA.

Proper lighting makes a big difference in picture contrast quality. It is best to have a light at, or just behind, the camera directed at the subject to remove shadows caused by the usual overhead lights. Do not crank up the video gain control to bring up dark areas as the bright areas will over modulate giving sync buzz, instability and may splatter the band.

With color cameras, try to use only one type of lighting...do not mix sun light through a window, incandescent and florescent lamps with each other or the colors will shift as you swing the

camera. Set the color camera white balance every time you first turn on the camera by aiming at an all white sheet illuminated by the same type of light in the scenes you will be showing. For outdoors especially public service events, CCD or MOS cameras are preferred over vidicon types as they will not normally be damaged if accidentally aimed at the sun.

Now that you have made it through Tom's introduction to Amateur television, I would advise you to go to his P.C. Electronics site on the internet, <http://www.hamtv.com> there you will find a plethora of information on the subject and also see his online catalog where you can purchase transmitters, receivers and accessories that will enable you to participate in all aspects of Amateur television.

April/2008 drm